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PRESENT SITUATION AND DEVELOPMENT ASPECTS OF THE ANIMAL FEED INDUSTRY IN GHANA

Information paper*

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CONTENTS

		Paragraphs	Page
	Summary		3
I.	Structure of the animal feed production industry in Ghana	1 - 17	4
II.	Economic factors which influence the animal feed production and utilization sector	18 - 20	6
III.	Action to be taken to utilize agro-industrial by-products and residues for production of animal feed	21 - 23	7
IV.	Financial action	24 - 26	8
V.	Existing agricultural raw materials in Ghana which are potential sources for the production of animal feed	27 - 31	8
VI.	Role of small- and medium-scale enterprises in the animal feed production sector	32 - 34	9
VII.	Local manufacture of animal feed production equipment and import requirements	35 - 36	10
VIII.	Present constraints affecting the animal feed industry in Ghana	37	10
IX.	Animal feed market in Ghana	38 - 39	11
X.	Proposals and measures to strengthen regional co-operation at all levels	40	11

Tables

Table 1:	Livestock population in Ghana	13
Table 2:	Index of livestock population	13
Table 3:	Meat production	13
Table 4:	Index of meat production	14
Table 5:	Land use pattern in Ghana	14
Table 6:	Feed resource production from natural grassland and crop residues	15
Table 7:	Amount of feed resources from natural grassland and crop residues that are potentially consumable	16
Table 8:	Production of selected food crops	17
Table 9:	Some potentially-available protein sources in Ghana	18
Table 10:	Yield of selected food crops: average for 1987-1990	19
Table 11:	Estimated level of per capita consumption of selected food crops	19

SUMMARY

The development of the animal feed industry in Ghana is described in the context of land use pattern, current agricultural practices, available feed resources, and utilisation of crop residues. For ruminants which depend on forage, shrubs and trees, the use of agro-industrial by-products during the dry season will ensure that weight loss is minimised and the productive performance is improved.

Agricultural technology should be improved in order to increase the output of cereal and other crops and reduce the scarcity and high cost of these commodities for feed which particularly threaten the pig and poultry enterprise. Further research is necessary in order to define the limits of inclusion, toxicity, and performance of animals on feed containing agro-industrial by-products.

To encourage the use of agro-industrial by-products in practical feeds, there is a need to strengthen the extension services between the feed producers and the farmers. Credit incentives should be given by the Government to feed producers who use a stipulated minimum amount of agro-industrial by-products in their feeds.

Government policies on agricultural inputs, credit facilities, and guaranteed prices need to be reviewed to encourage investment in agriculture and especially in feed production as an enterprise. In order to promote co-operation in industrial development among countries within the region, countries which have comparative advantage in some food/feed ingredients should be encouraged to sell such products to one another.

I. STRUCTURE OF THE ANIMAL FEED PRODUCTION INDUSTRY IN GHANA

1. The livestock feed industry in Ghana falls into two categories depending on the type of animal:

(a) Ruminant species which depend on natural grasslands abundant during the rainy season, and require feed supplement during the dry season;

(b) Monogastric animals (poultry and pigs) which depend on crop and other products.

2. In either case, the feed industry relies on small livestock owners who keep a few herds of cattle or goats and sheep on their farms, while the poultry farmers rely on commercial feeds prepared by the farmers or companies from maize or fish meal either for use on their farms or at small industrial locations where they are used for their animals or sold to the livestock farmers in their locality and beyond. Tables 1 and 2 show the livestock population in Ghana during the period 1987-1990.

3. Despite the modest increase in the livestock population in Ghana, there has only been a 10 per cent increase in the meat supply from domestic sources. Tables 3 and 4 show that both cattle and poultry (each contributing one-third of the total meat supply) contribute the bulk of the animal protein supply. The supply of protein from cattle or poultry sources is generally expensive and is mainly attributed to the problem of feed availability, water supply, availability of improved breeding stock, disease control, and high lending policies to the livestock sub-sector.

4. Feed takes between 60-85% of the cost of producing poultry and pigs. Factors which will promote the use of agricultural industrial by-products in feed formulation in order to develop the livestock industry are the focus of the paper.

Ruminants - cattle, goats, sheep

5. It is generally believed that ruminants only require pasture for sustenance and development, and an unlimited supply of natural grassland exists in the free range including herbs and shrubs. The major problem is to provide these animals with food and water during the dry season, when weight loss (up to 30% live weight) and poor reproductive performance occur. Table 5 shows the land-use pattern in Ghana. It can be seen that permanent pasture land has been decreasing at the expense of farming and other uses which suggests that feed resource use can be increased only through crop production. Local pasture (grass) is low in total digestible crude protein and high in fibre. It is over grazed because of over stocking and communal ownership of the grassland.

6. The grazing animal does not harvest more than 50% of the potentially herbaceous biomass nor do forage resources from trees and shrubs form more than 20% of the normal feed of the grazing animals. Large herd owners allow the pasture to be overgrazed and soil degradation occurs. In the humid forest and derived savanna zone where grazing is available all the year round, the threat of trypanosomiasis has limited cattle production and enhanced small ruminant production. Numbers of large animals are restricted because they can destroy arable crops; they are thus fed with household scrap.

7. During the rainy season, the dry matter content of the forage is almost 80% and this decreases to 20% during the dry season. It is during the dry season that many cattle farmers resort to the use of crop residues.

8. Crop production statistics of Ghana are shown in Table 6. Crop residues from these values have been estimated on factors obtained by considering the yield of potential food available from these crops during processing. Table 7 shows the potential feed resource production from grassland and crop residues. The table indicates that for Ghana, crop-residues could give about 61% of the dry matter, 65% of the total digestible nutrient and 70% of the digestible crude protein to animal feed requirements.

9. Crop residues, however, are of different types and characteristics and are obtained from crop processing operations. Quantitatively, they consist of the small households to industrial agricultural by-products from operators. In general, they are of low value in monetary terms and in nutrient content and often represent waste to the layman. In some cases, they are often high in moisture, and usually require further processing in order to utilise them in feed formulation. They are, however, high in nutrient and easily digestible.

10. Much success has been recorded in supplementing livestock feed with agricultural by-products in order to maintain the live weight of the animal and productive performance. They include cocoa pod husk, banana and plantain leaves, cassava peels, rice straw, cereal offal, sugar-cane molasses, pineapple peels, etc.

11. In many parts of Ghana, rice straw treated with urea is widely used as a supplement for ruminants during the dry season. Other cereal by-product residues need further treatment or reduction in size before being fed to ruminants or incorporated as a supplement. It has been shown that modifying cereal straw by treating it with caustic soda or urea could serve as supplementary feed to ruminants. The problem is that the technology for modification or treatment has not been widely transferred or adopted by the livestock farmers.

12. Livestock is increasing at an average rate of 4.18 per cent which means that natural grazing cannot continue since all land suitable for cultivation will be required to produce human food. It is now known that pasture lands have been decreasing at the expense of farming and other uses, an indication that it might be possible to increase feed resources through increased crop production in the short-term, the residue of which will be used as feed supplement. The current agricultural production technology suggests that crop output cannot keep pace with population growth let alone leave a surplus for livestock feed. What has been recommended is that improved pasture consisting of legumes and grass be established and managed for higher carrying capacity while crop residues could be used as supplementary feed during the dry season.

Monogastric animals: poultry and pigs

13. Although Ghana has always been a crop-production nation, with fishing and hunting as associated business, a large number of people are engaged in the commercial poultry and piggery business; more than 50% of the animal protein demand of the population is derived from locally-raised poultry. Many Ghanaians do not receive the minimum daily recommended levels of protein because high feed costs have led to an irregular supply of almost all animal protein products. Feed takes between 60-85% of the variable cost of producing poultry and pigs in Ghana. The main reason is the inadequate production or scarcity of the major basic feed ingredients, notably maize and fish meal. The

competition for these ingredients by man is also responsible for their scarcity for use in livestock feed.

14. The main feed ingredients are not locally available in reasonable quantity and have to be imported. Maize, for instance, has to be imported almost every year since local production cannot keep up with the demand. Much effort and research have been directed at replacing the main feed ingredients in order to reduce the cost of feed using a number of crops or their by-products. Some degree of success has been reported but there is a limit to how the substitution could be made without affecting the quality and performance of the animal, either for meat or egg production. The use of alternative and cheaper resources of protein and energy in feeding farm animals has become a vital point of interest for the growth of the local livestock industry. Table 8 shows the production of selected food crops.

15. While the protein source in poultry feed can be replaced by vegetable protein, there is no cheap substitute for maize. Cassava is very expensive to produce under the present farming conditions in Ghana although it is a feed ingredient in other parts of the world. There is a possibility that in future cassava might be used in livestock feed if new improved varieties are planted and the necessary inputs supplied so that the maximum yield can be obtained and considered as feed crop in its own right.

16. By their nature, agro-industrial by-products when properly processed and incorporated as replacement or supplement in conventional feed formula, are more digestible and will reduce costs thereby stimulating development in the livestock sector.

17. However, extension services need to be strengthened, and research should be undertaken to solve the problem relating to:

- further processing and cost of using agro-industrial products;
- storage characteristics, e.g. rancidity in high fat ingredients, eg. groundnut cake, soy bean cake.

II. ECONOMIC FACTORS WHICH INFLUENCE THE ANIMAL FEED PRODUCTION AND UTILIZATION SECTOR

18. Because of the need to maintain the performance of imported and local cattle particularly during the dry season, and with the advent of modern intensive rearing of poultry and pigs to meet the demand of the population for eggs and meat, livestock feed production on a commercial scale has become an important economic activity of livestock production. Birds which were imported needed constant and good-quality feed, and profit consideration by feed millers aside, the commercial feed production was part of the package to improve meat supply by importation of birds. Another interest was the need to utilise the by-products from flour milling operations and breweries. About 30 years ago, the Ghana Food Distribution Complex at Tema had a programme to utilize the wheat offals.

19. There are a few reports on the use of agro-industrial by-products in practical livestock feeds in Ghana, partly due to lack of appreciation of their nutritional importance and the reluctance of the farmers to use them. The small quantities of agricultural by-products that are available are scattered over a wide area and it requires investment in transportation, technology and

further processing to incorporate them into practical feed. There is also a need to market the feed containing the by-products. But perhaps more important is the increasing scarcity of conventional feed resources, as well as uncertainty of production and high prices. At present, certain economic considerations underlie the development of the feed production industry in Ghana. These are:

i. The need to contribute to the agricultural sector through animal husbandry.

ii. The need to supply feed to imported poultry for which there has been a considerable investment.

iii. The need to reduce the cost of feed in order to optimise the use of major feed ingredients required for local foods. The need to contribute to development activities and supply of feed to animals and maximise the use of crop resources are some of the factors which influence animal feed production. The low cost of feed will be translated into lower cost of animal protein and promote better health.

iv. The need to utilise the by-products which could have been disposed of as waste without any monetary value. As stated earlier, agro-industrial by-products such as groundnut cake, SBM, PKM, when properly treated, and incorporated at a level which does not adversely affect the efficiency or performance of the animal, could contribute to the animal product (meat, eggs, milk).

v. The necessity, in some cases, to further process the agro-industrial by-product prior to its use. The cost recovered will not only benefit the animal feed producer but will reduce the cost of disposing of the by-products.

20. It will be realized that farmers at the home level have raised pigs and poultry on by-products of food processing operations. The animals thus contribute to the value of the crop and when they are sold, they provide some income to their owners.

III. ACTION TO BE TAKEN TO UTILIZE AGRO-INDUSTRIAL BY-PRODUCTS AND RESIDUES FOR PRODUCTION OF ANIMAL FEED

21. In order to utilise agro-industrial by-products for the production of animal feed, two lines of approach are suggested:

(a) To incorporate the by-product into a conventional maize-based diet as replacement;

(b) To develop a new feeding system based entirely on the use of agro-industrial by-products.

22. It must be realized that the first proposition is easy to achieve and is highly recommended. To adopt this method for practical feeding, there is need to screen the locally-available feedstuff for its chemical composition, level of incorporation, toxicity and effect on production performance on the stock.

23. The main organizational problems limiting the use of agro-industrial by-products are related to:

(a) lack of transport facilities to collect the by-products from the small-holder crop-processors to a central location where they could be reprocessed by drying to reduce the bulk and size to incorporate them into regular feed or modify the by-product where necessary;

(b) lack of an organized marketing system whereby the by-products are traded like the main crop - e.g. the cocoa pod husk is seen as a waste with no real value. If the company is interested in re-processing and selling it to feed millers there will be a greater revenue to the cocoa farmers generated by the sale of the cocoa pod husk in addition to the revenue from the cocoa beans.

IV. FINANCIAL ACTION

24. Agro-industrial by-products are generally bulky and low in nutritive value and are usually considered as industrial pollutants by food processors. For example, because of lack of demand for the sugar bagasse produced by a distillery company, this product is burnt by the factory. It is possible to devise a system of reward to industrial processors who are able to market the by-products after investing in re-processing plants in order to ensure that such by-products are utilised in feed production. Here, additional investment is required.

25. The revenue derived from the sale of the agro-industrial by-product represents an insignificant source of income to the crop producer or processors, but the amount could be used to offset the cost of disposing the waste.

26. In order to promote the use of agro-industrial by-products, the government could introduce a credit scheme to industrial feed millers who use a certain minimum percentage of the locally-produced by-products in their formulas. With this method, there would be a deliberate effort to consider the by-product as a feed resource and thus reduce the pressure on the main food crop.

V. EXISTING AGRICULTURAL RAW MATERIALS IN GHANA WHICH ARE POTENTIAL SOURCES FOR THE PRODUCTION OF ANIMAL FEED

27. Almost all conventional agricultural raw materials, i.e. cereal, cassava or the by-products of wheat brans, rice husk, cassava peel, plantain peel, brewers spent grain, sugar molasses, can be used for the production of animal feed.

28. The main limitation for the use of the main crop is the competition for use of the same crop as food and the prohibitive cost of production under the present agricultural technology and practice. It costs three times more to produce the same quantity of cassava than maize and the economics of production are not in favour of using conventional food crops for livestock feed or for their by-products.

29. The quantities of crop products such as maize and cassava are hardly sufficient to satisfy human needs under the present farming system let alone

to use them in production of feed. It is only in the foreseeable future when agricultural technology and farming systems have improved that conventional feed will be used in feed production.

30. The crop residues (or agro-industrial by-products) on the other hand, will be relied upon as an important feed resource in Ghana in the not too distant future. What is required is determination of the value and level of incorporation after they have been treated.

31. It has been demonstrated that fish meal, which is a protein source in typical poultry feed, could be replaced by vegetable protein. A list of the potentially-available proteins available in Ghana (Table 9) indicates that research is needed to determine the acceptable level of substitution of the vegetable protein, toxicity factors and their storage characteristics and the processing techniques to be adopted in optimising their use in the production of animal feed.

VI. ROLE OF SMALL- AND MEDIUM-SCALE ENTERPRISES IN THE ANIMAL FEED PRODUCTION SECTOR

32. The distinction between small- and medium-scale enterprises is based on the scale of feed production, capital investment, number of employees and organizational set-up in terms of marketing outlets or network and quality assurance. The animal feed production sector is dominated by small-scale operators characterised by small livestock owners who have either a few herds of a maximum of 100 head of cattle and/or goats and sheep or poultry and pigs. In the Upper East, West and derived Savanna Zone in the southern parts of Ghana, cattle, sheep or goats are kept for cash income, prestige and payment of dowry and are allowed to graze on the local pasture shrubs or browse and feed on kitchen wastes or scraps from crop residues during the off-season. It is only in recent times that the cattle have been fed on urea-treated rice straw as a supplement in order to maintain their body weight during the dry season.

33. The small-scale poultry and pig enterprises occasionally prepare their own feed when they can afford the investment in milling machines and ingredients to prepare the feed for their livestock production of up to 1000 metric tons/year. Because of the technical difficulties which the small operators encounter when the machines break down or the feed ingredient becomes prohibitively expensive, small enterprises resort to buying their feed from medium enterprise feed operators.

34. Medium-scale animal feed enterprises comprise two types:

(a) Those which are owned either by Ghana nationals in partnership with foreign partners, or those which are owned exclusively by Ghana nationals. In most cases, poultry or pigs are kept and enough feed produced to meet their needs with the surplus being sold to a few clients who purchase their drugs or birds from the hatchery.

(b) The other class of medium-scale feed producers were able to sustain a 15.6% growth (in 1991) to keep pace with growth of poultry in spite of the enormous constraints under which they operate. Government assistance is necessary in order to enable these enterprises to contribute to the industrial development of Ghana in the food production sector.

VII. LOCAL MANUFACTURE OF ANIMAL FEED PRODUCTION EQUIPMENT AND IMPORT REQUIREMENTS

35. The small- and medium-scale animal feed production sector relies on small-scale equipment which is simple to operate. Local plate mill, which is powered by simple electrical motors is quite common, especially among the small-scale feed producers. The medium-scale feed producers have able technicians to carry out routine maintenance of their equipment and machinery and assure continuous production when the feed ingredients are available.

36. There is also a large pool of artisan and small foundries in the township where the enterprises are located where replacement parts can be improvised. Very few machine items are imported from the original suppliers of the equipment, thus ensuring that there is continuous production.

VIII. PRESENT CONSTRAINTS AFFECTING THE ANIMAL FEED INDUSTRY IN GHANA

37. As stated earlier, the animal feed industry in Ghana is not expanding to meet the demand either on a short-term or long-term projection of livestock production and entrepreneurship development. The growth of the feed industry is constrained by the following:

i. Crop production, especially food crops, is not growing at a rate that would leave enough surplus for the livestock feed sector due to inadequate use of inputs and adoption of inappropriate farming technology. The Government should provide the necessary incentives to encourage increased activity in the farming sector. These incentives could include credit to farmers, provision of insurance schemes and providing inputs - fertilizer, land-clearing incentives using tractors, etc. Because of the low output of the main ingredients, feed producers resort to importation and low capacity utilization of their equipment and capital outlay. The current rate of borrowing money for agricultural ventures (23-24%) is a disincentive to prospective investment because of the risky nature of agricultural enterprises.

ii. Commercial grazing areas with improved pasture consisting of grass/legume mixture should be established in those areas where cattle is currently grazing uncontrolled.

iii. Extension services which will bring the problems of the farmer to the researcher should be strengthened and equipped with qualified staff. These services should also offer training and educate feed producers in the value of agro-industrial by-products and the level to substitute in their formula.

iv. Most animal feed producers stated that the Government's monetary policy, especially on credit, is a disincentive to borrowing for expansion and even operation. It is recommended that this aspect be reviewed so that feed producers could buy and store maize and fish meal, thereby helping the farmers of these commodities.

v. A Government liberalization policy has encouraged the import of food and feed ingredients, thus rendering local production uncompetitive with the cheap imported ones. The poultry industry and the beef market have thus suffered and those who invested in these sectors are finding it difficult to survive. It is suggested that Government policies should be consistent in order to protect local investors who are contributing to development.

vi. There is concern that besides the high price, the quality of locally-produced fish meal is poor, often containing a higher level of sand than is desired. It is suggested that the feed millers should educate the fishermen on the technology of catching and drying fish so that they can produce according to specifications.

vii. Research is needed to determine which of the feed ingredients could be replaced by local ingredients or agro-industrial by-products. Support should be provided by researchers to carry out investigations rather than relying on importation of those ingredients which could be sourced locally. Infrastructural facilities should also be set up by the feed producers to test the quality of the product formulated with local ingredients or those purchased on the open market. This will enable both the producer and user of the feed to establish mutual confidence.

IX. ANIMAL FEED MARKET IN GHANA

38. It was suggested that commercial ranching with improved pasture be set up so that cattle stocking rate, grazing intensity and soil degradation could be controlled. For feeding during the dry season, greater emphasis should be placed on agro-industrial by-products under the feedlot system. Since free grazing areas are becoming limited, it is proposed that industrial grazing, together with greater use of well-treated crop residues will minimise the effect of nutritional problems on livestock production in Ghana.

39. There is a need to develop a feed production sector as an industrial activity if the agricultural system that ensures improved crop output is to be effective. Incentives should be given to enable medium feed producers to operate at higher capacity than is currently the case. Small feed operators should be given franchise to produce under specified conditions so that the quality of the poultry feed is guaranteed. There are well-known brand names on the market with their organizational set-up, and facilities for investment. A better scale of operation is thus envisaged.

X. PROPOSALS AND MEASURES TO STRENGTHEN REGIONAL CO-OPERATION AT ALL LEVELS

40. The following proposals and measures to strengthen regional co-operation are suggested:

i. The high cost of feed ingredients is one of the main constraints of livestock enterprise in Ghana. Because of the low production of maize and the seasonal nature of fish meal, etc., the producers had to import ingredients from South America and the USA. There are some countries in West Africa which can supply these ingredients at reasonably low prices comparable to those paid for imports from South America or the USA.

Fish meal could be imported from Senegal and yellow maize from South Africa. Improved high yielding varieties of cassava have been released by the International Institute of Tropical Agriculture, Ibadan. It is now possible to obtain a yield of 29 tons/ha rather than 7.9 tons/ha which is the current production figure. By planting the new cassava varieties with the correct inputs, it is possible to increase the yield of cassava and have enough for the feed sector. It is possible to import dried cassava chip from

neighbouring West African countries for this purpose should it not be possible to open up new land for cultivating cassava.

ii. As a way of promoting interregional co-operation, it might be profitable to sell cattle from one country to be fattened in another where industrial cattle ranches are established. The economic factors clearly outweigh the sentimental or cultural issues.

iii. The technology of agro-industrial by-product utilization should be evaluated, promoted and disseminated to industrial enterprises in the region.

iv. Regional laboratories for analyzing the quality of commercial feed should be set up by either the Government or feed producers, and animal nutritionists should be encouraged to move across borders to exchange knowledge and ideas about feed formulation, etc.

v. Governments in the region should review their policies on enterprise development and provide a conducive environment to encourage investment in the feed sector through tariffs, tax incentives and legal instruments.

vi. Where one or more feed producers have a comparative advantage on the economics of feed production, appropriate incentives should be provided to enable the company to open up in another country or operate under a franchise in that country. This will promote and facilitate trade, industrial development and ensure regional co-operation.

Table 1: Livestock population in Ghana
('000)

Type of livestock	1987	1988	1989	1990
Poultry	8,214	8,040	8,738	9,686
Sheep	1,989	2,046	2,212	2,555
Goats	1,901	1,991	2,363	2,834
Cattle	1,170	1,145	1,136	1,158
Pigs	398	478	559	677

Source: Agriculture in Ghana: Facts and Figures issued by Ministry of Agriculture, Accra, November, 1991.

Table 2: Index of livestock population
(1984 - 1986 = 100)

Type of livestock	1987	1988	1989	1990
Poultry	110	108	117	130
Sheep	103	106	115	133
Goats	116	121	116	173
Cattle	109	107	106	108
Pigs	93	111	130	157

Source: Agriculture in Ghana: Facts and Figures issued by Ministry of Agriculture, Accra, November, 1991.

Table 3: Meat production

Type of Livestock	Estimated 1985	Meat 1987	Production 1989	(Tonnes) 1990
Cattle	14,254	15,661	18,000	19,800
Sheep	8,943	8,948	8,500	8,580
Pigs	8,262	7,979	5,040	5,544
Poultry	8,020	6,571	3,200	3,520
Goats	6,020	7,128	8,580	8,580
Total	45,499	46,287	43,400	46,024

Table 4: Index of meat production
(1985 = 100)

Type of Livestock	1987	1988	1989	1990
Cattle	109	107	106	108
Sheep	103	106	115	133
Pigs	93	111	130	157
Poultry	110	108	117	130
Goats	116	121	116	173

Table 5: Land use pattern in Ghana

Land use characteristics	10^3ha		% Change
	1971	1986	
Total area	23854	23854	-
Land area	23002	23002	-
Water bodies	852	852	-
Permanent cropland	1600	1720	7.5
Arable lands	1000	1140	14.00
Forest and woodlands	9400	8350	-11.11
Permanent pastures	3560	3410	- 4.21
Other lands	7442	8382	12.63

Source: F.A.O. (1988) Food and Agriculture Organization Production Yearbook.

Table 6: Feed resource production from the natural grassland and crop residues

Nutrient Characteristics	Sources	1970	1975	1980	1985	% Contribution in the average total
Dry matter 10^6mt	Grass	7.50	7.40	7.30	7.20	43.39
	Browse/ Shrubs	3.19	3.15	3.10	3.06	17.67
	Crop Residues	7.01	6.06	6.66	6.77	39.03
	Total	17.70	16.11	17.06	17.03	100.00

Nutrient Characteristics	Sources	1970	1975	1980	1985	% Contribution in the average total
Total digestible nutrients 10^6mt	Grass	3.80	3.75	3.70	3.65	39.12
	Browse/ Shrubs	1.97	1.95	1.91	1.89	20.16
	Crop Residues	4.06	3.54	3.92	3.95	40.62
	Total	9.83	9.24	9.53	9.49	100.00

Nutrient Characteristics	Sources	1970	1975	1980	1985	% Contribution in the average total
Digestible crude protein 10^3mt	Grass	128.25	126.54	124.83	123.12	19.27
	Browse/ Shrubs	261.58	258.30	254.20	250.92	38.05
	Crop Residues	270.46	261.82	307.30	273.80	42.68
	Total	644.50	635.86	681.34	647.84	100.00

Source: J.E. Fleischer (1992) Dept. of Animal Science, University of Ghana, Legon.

Table 7: Amount of feed resources from natural grassland and crop residues that are potentially consumable

Nutrient Characteristics	Sources	1970	1975	1980	1985	% Contribution in the average total
Dry matter 10^6mt	Grass	3.75	3.70	3.65	3.60	33.64
	Browse/ Shrubs	0.64	0.63	0.62	0.61	5.76
	Crop Residues	7.01	6.06	6.66	6.77	60.60
	Total	11.40	10.39	10.93	10.98	100.00

Nutrient Characteristics	Sources	1970	1975	1980	1985	% Contribution in the average total
Total digestible nutrients 10^6mt	Grass	1.90	1.87	1.85	1.82	30.39
	Browse/ Shrubs	0.40	0.39	0.38	0.38	6.37
	Crop Residues	4.06	3.54	3.92	3.95	63.24
	Total	6.36	5.80	6.15	6.15	100.00

Nutrient Characteristics	Sources	1970	1975	1980	1985	% Contribution in the average total
Digestible crude protein 10^3mt	Grass	64.13	63.27	62.42	61.56	16.01
	Browse/ Shrubs	52.33	51.66	50.84	50.18	13.06
	Crop Residues	270.46	261.82	307.30	273.80	70.93
	Total	386.91	376.75	420.56	385.54	100.00

Source: J.E. Fleischer (1992) Dept. of Animal Science, University of Ghana, Legon.

Table 8: Production of selected food crops
('000 MT)

Crop	1987	1988	1989	1990
Cassava	2728	2300	3320	2717
Yam	1185	1200	1280	877
Plantain	1078	1200	1040	799
Cocoyam	1012	1115	1200	815
Maize	598	600	715	553
Sorghum	206	178	215	136
Groundnut	191	230	200	113
Millet	173	192	0.80	75
Rice/Paddy	81	105	67	81
Pineapple	8	9	10	10

Source: Ministry of Agriculture. The quantity of by-products generated can be calculated using the fact that root crops in general yield 40% waste. Rice paddy yields 50% waste and for sorghum, maize and millet the by-product is generated in the order of 30 per cent.

Table 9: Some potentially-available protein sources in Ghana

Protein sources	Why used	Upper limit of inclusion (%)	Reason
Soy bean meal	Protein; energy	20 - 30	Soy in fat
Groundnut cake	Protein; energy	20	Fat Rancidity
Copra cake	Protein	10	Poor palatability
Palm kernel cake	Protein		Low palatability
Cotton cake	Protein	5	Colouring effect
Rice bran	Dilution		
	Protein	10	Fibre, Fat
Maize bran	Energy	10 - 15	Fibre, Moisture
Wheat bran	Protein	25	Fibre
spent grain	Energy, protein	15	Fibre
Pito mash	Protein	10	Fibre, tannin
Oil palm slurry	Energy	10	Rancidity
Cocoa pod husk	Dilution, cost	10	Fibre
Cassava peel meal	Dilution cost	10 - 15	Fibre, Low protein fibre
Coffee pulp hull	Dilution, cost	2.5	Fibre
Cassava	Energy	20 - 50	Low protein, dustiness
Sorghum	Energy, protein	60	Tannin
Millet	Energy	20	
Cassava leave meal	Protein, pigment	15	Fibre, tannin
Bauhinia leaf meal	Pigment, protein	2.5	Low palatability tannin, nitrates
Gliricidia leaf meal	Pigment, protein	2.5	- do -
Leucena leaf meal	Pigment, protein	5	Mimosine,
Grass meal	Pigment	5	Fibre
Rubber seed meal	Energy	20 - 40	Antifertility amino acid def.

Source: S.A. Osei (1991), Dept. of Animal Science. Ghana.

Table 10: Yield of selected food crops: average for 1987-1990

Crop	Yield (Mt/Ha)	Achievable yield (Mt/Ha)*
Cassava	7.8	28.0
Plantain	7.1	10.0
Yam	6.1	10.0
Cocoyam	5.6	8.0
Groundnut	1.4	2.0
Maize	1.2	5.0
Rice	1.0	3.0
Cowpeas	0.9	2.0
Millet	0.7	2.0
Sorghum	0.7	2.5

* Indicate yields that have been achieved in isolated cases due to more effective extension and other logistic support.

Table 11: Estimated levels of per capita consumption of selected food crops

Commodity	Kg/1980	Head/1985	Year/1990
1. Roots and tubers,			
cassava,	145.2	146.3	148.0
yam	44.2	43.8	43.3
cocoyam	-	-	54.0
2. Plantain	82.2	82.5	83.0
3. Cereals	84.8	85.4	88.2
Maize	38.4	39.2	40.3
Rice	12.4	12.0	13.3
Millet	17.0	17.1	17.3
Sorghum	17.0	17.1	17.3
4. Pulses and nuts	22.4	22.5	22.6
Groundnuts	21.5	21.6	21.7
Cowpeas	0.9	0.9	0.9